MassDEP is interested in comments on the utility and clarity of this draft document. Please submit comments by **August 15, 2008** to MassDEP, One Winter Street, Boston, MA 02108 Attn: Liz Callahan or elizabeth.j.callahan@state.ma.us

Indoor Air Threshold Values for the Evaluation of a Vapor Intrusion Pathway

TECHNICAL UPDATE
POLICY # 08-XXX

Review Draft for Discussion Purposes Only

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Updates:

Sections 5.9 and 8.7, *Indoor Air Sampling and Evaluation Guide*, WSC Policy #02-430 (April, 2002)

Section 2.3, *Guidance for Disposal Site Risk Characterization,* WSC/ORS #95-141 (1995)

Table 4-11, *Characterizing Risk Posed by Petroleum Contaminated Sites: Implementation of the MADEP VPH/EPH Approach*, WSC Policy #02-411 (2002)

This document provides threshold values for evaluating indoor air data as part of a vapor intrusion pathway investigation. These threshold values, based on MassDEP's Typical Indoor Air Concentrations (2008) and MCP risk management criteria, are intended to expedite the evaluation of indoor air data collected as part of MCP response actions. In the absence of evidence to the contrary, if measured indoor air chemical concentrations are below these threshold values, parties conducting response actions may conclude that a vapor intrusion pathway is not present for purposes of risk characterization or identifying Critical Exposure Pathways.

This document is intended solely as guidance. It does not create any substantive or procedural rights, and is not enforceable by any party in any administrative proceeding with the Commonwealth. This document provides guidance the Department considers acceptable for meeting the performance standards set forth in the MCP. Parties using this guidance should be aware that there may be other acceptable alternatives for achieving and documentIng compliance with the MCP.

Overview

Under the MCP, determining whether a vapor intrusion pathway is present at a disposal site is necessary to adequately characterize risk and evaluate whether No Significant Risk has been achieved in support of a Response Action Outcome. The presence of a vapor intrusion pathway at residences or schools is also considered a Critical Exposure Pathway that requires elimination or mitigation of the pathway, to the extent feasible.

At some disposal sites, the existence of a vapor intrusion pathway is apparent based on the presence of odors, field screening or other readily observable site conditions. In other cases, the existence of a vapor intrusion pathway is less apparent and may involve an examination of multiple lines of evidence to determine whether an impact to indoor air in the structure of concern is present or likely.

Lines of evidence relevant to evaluating a potential vapor intrusion pathway include, but are not limited to:

- OHM concentrations in groundwater near the structure (i.e., OHM concentrations at/above GW-2 standards);
- OHM concentrations in soil near the structure;
- OHM concentrations in ambient air near the structure;
- OHM concentrations in soil gas beneath or near the structure;
- results from analytical screening of cracks in the foundation, slab, sumps or along other preferential vapor transport pathways; and
- OHM concentrations in indoor air.

Which lines of evidence are generated in the course of a vapor intrusion pathway investigation, the level of effort needed, and the order in which they are generated varies from site to site and depends on the findings of each assessment event, the complexity of site conditions, the sensitivity of receptors, and the evolution of the site-specific Conceptual Site Model. Not all assessments of potential vapor intrusion pathways, for example, lead to indoor air sampling. An evaluation of groundwater concentrations and/or sub-slab soil gas concentrations may result in a conclusion that a vapor intrusion pathway is unlikely or not present, and therefore, indoor air samples are unnecessary.

In the event that indoor air samples are taken as part of a vapor intrusion pathway investigation, however, it is important to recognize that low concentrations of some chemicals observed in indoor air may be unrelated to a disposal site and may instead be due to the use or storage of household or consumer products, cigarette smoke, ambient air, or the off-gassing of building materials that comprise the structure of concern.

Typical Indoor Air Concentrations

Large-scale studies of indoor air quality in buildings unaffected by a vapor intrusion pathway are useful in identifying the types and concentrations of chemicals that may typically be expected in indoor air from building-related sources absent a vapor intrusion pathway. In this regard, MassDEP developed a list of Typical Indoor Air Concentrations (POLICY #08-XXX, 2008). This list provides the 50th, 75th and 90th percentile values based

on data sets from several recent studies of indoor air quality in residential structures. Typical Indoor Air Concentrations in comparison to measured indoor air concentrations may be used as one line of evidence in an evaluation of a potential vapor intrusion pathway.

Please note that MassDEP is using the term “Typical Indoor Air Concentrations” instead of “Indoor Air Background” to refer to the updated list of indoor air values. MassDEP is intentionally avoiding the term “background” as “background” has specific MCP regulatory associations that may not always be intended or apply when discussing the use of indoor air values from studies as a line of evidence in a vapor intrusion pathway investigation.

In the context of the MCP, background is the level of OHM present at a location absent a release to the environment. For indoor air, background is what is present in any given structure, absent a vapor migration pathway related to a release. Background levels do not require mitigation under the MCP. Background in any particular medium is typically determined by measuring the levels of OHM in nearby, similar areas that have not been affected by a release of OHM. For soil and groundwater, background concentrations can be determined by collecting samples from nearby, similar, unaffected properties. However, background indoor air concentrations are not as easily determined. Due to variations in building materials, use and storage of consumer products, ventilation rates, and other factors specific to each structure, indoor air chemical concentrations observed in nearby, unaffected structures may be much higher or much lower than the building under investigation. As a consequence, it is not possible to determine with confidence the building-specific background concentration of a chemical that would be present in the absence of any vapor intrusion pathway.

Consideration of Risk

While the comparison of measured indoor air concentrations to Typical Indoor Air Concentrations may be a central consideration in evaluating the likelihood of a vapor intrusion pathway, it should never be used as the sole basis to justify a condition of No Significant Risk pursuant to the MCP provisions at 310 CMR 40.0902(3). Typical Indoor Air Concentration values are not synonymous with “background,” as that term is defined and used in the MCP. **In every case where the measured concentrations in indoor air pose a significant risk to human health, even where the concentrations fall at or below the Typical Indoor Air Concentrations, it is always necessary to evaluate multiple lines of evidence to determine, based on the weight of the evidence, whether a vapor intrusion pathway is likely present.**

Threshold Values

In an effort to simplify consideration of whether measured indoor air concentrations pose significant risk and/or are within the range of Typical Indoor Air Concentrations, and to clearly indicate when multiple lines of evidence appear warranted to determine whether a vapor intrusion pathway is present, MassDEP has compiled a table of Threshold Values for Multiple Lines of Evidence (**Table 1)**. These Threshold Values, based on MassDEP’s

Typical Indoor Air Concentrations and MCP risk management criteria, are intended to expedite the evaluation of indoor air data collected as part of MCP response actions.

Table 1 combines 90th percentile values from MassDEP's list of Typical Indoor Air Concentrations and risk-based concentrations calculated using an Excess Lifetime Cancer Risk (ELCR) of 1 X 10^{-6} and a Hazard Index (HI) of 0.2, and indicates the basis for the Threshold Value (e.g., risk or 90th percentile value) for each chemical. Attachment A describes how the Threshold Values were established, and Attachments B and C provide the values used to set the Threshold Values.

Note that for Threshold Values based on risk, the listed concentration represents the concentration at which the chemical may pose a significant risk when a mixture of chemicals is present. If there is only one contaminant present, the risk-based concentrations may be determined using an ELCR of 1X10^{-5} and an HI of 1.

Application of Threshold Values for Multiple Lines of Evidence

Guidance is presented below on the appropriate application of the Threshold Values in Table 1 in comparison to measured indoor air concentrations associated with the disposal site relative to determining whether a vapor intrusion pathway or Critical Exposure Pathway may be present and/or an evaluation of multiple lines of evidence is warranted:

- Where the measured indoor air concentrations of chemicals associated with the disposal site are at or below a Threshold Value, MassDEP considers further investigation and lines of evidence unnecessary. This assumes that the indoor air results are consistent with other site information and that appropriate and adequate testing has been conducted to obtain representative indoor air concentrations, including expected "worst case" conditions.

  Note that a vapor intrusion pathway may still be present at sites where indoor air concentrations are at or below a Threshold Value. MassDEP, however, does not expect parties to undertake additional response actions to assess or mitigate potential pathways in such cases as long as the concentrations measured in indoor air are at or below the Threshold Values.

- Where the measured indoor air concentrations of chemicals associated with the disposal site are above a Threshold Value, the measured concentrations may be indicative of a vapor intrusion pathway and, in the case of indoor air in a residence or school, a Critical Exposure Pathway. In such cases, it should be presumed that a vapor intrusion pathway exists, unless an evaluation of multiple lines of evidence demonstrates that the presence of a vapor intrusion pathway is not likely.

  If a vapor intrusion pathway is confirmed, then all of the chemicals associated with the disposal site measured in indoor air must be incorporated into further site assessment and risk characterization.

Table 1 Indoor Air Threshold Values

Chemical	CAS No.	Threshold for Multiple Lines of Evidence		Basis for Value
		µg/m^3	ppbv	
ACETONE	67-64-1	91	38	90th%
BENZENE	71-43-2	**0.30**	**0.094**	1.0x10-6 cancer risk
BROMODICHLOROMETHANE	75-27-4	**0.14**	**0.02**	1.0x10-6 cancer risk
BROMOFORM	75-25-2	5.2	0.50	Reporting Limit
BROMOMETHANE	74-83-9	**0.60**	**0.15**	90th%
CARBON TETRACHLORIDE	56-23-5	**0.54**	**0.086**	50th%
CHLOROBENZENE	108-90-7	2.3	0.50	Reporting Limit
CHLOROFORM	67-66-3	1.9	0.389	50th%
DIBROMOCHLOROMETHANE	124-48-1	**0.10**	**0.012**	1.0x10-6 cancer risk
DICHLOROBENZENE, 1,2- (o-DCB)	95-50-1	**0.72**	**0.12**	90th%
DICHLOROBENZENE, 1,3- (m-DCB)	541-73-1	**0.60**	**0.10**	90th%
DICHLOROBENZENE, 1,4- (p-DCB)	106-46-7	**0.5**	**0.083**	50th%
DICHLOROETHANE, 1,1-	75-34-3	100	25	Non-Cancer risk: HI=0.2
DICHLOROETHANE, 1,2-	107-06-2	**0.090**	**0.022**	1.0x10-6 cancer risk
DICHLOROETHYLENE, 1,1-	75-35-4	0.8	0.20	Reporting Limit
DICHLOROETHYLENE, CIS-1,2-	156-59-2	0.8	0.20	Reporting Limit
DICHLOROETHYLENE, T-1,2-	156-60-5	0.8	0.20	Reporting Limit
DICHLOROMETHANE (MeCl)	75-09-2	5.0	1.4	1.0x10-6 cancer risk
DICHLOROPROPANE, 1,2-	78-87-5	**0.13**	**0.028**	1.0x10-6 cancer risk
DICHLOROPROPENE, cis, 1,3-	10061-01-5	**0.60**	**0.13**	1.0x10-6 cancer risk
DICHLOROPROPENE, trans, 1,3-	10061-02-6	**0.60**	**0.13**	1.0x10-6 cancer risk
DIOXANE, 1,4-	123-91-1	**0.59**	**0.16**	1.0x10-6 cancer risk
ETHYLBENZENE	100-41-4	7.4	1.7	90th%
ETHYLENE DIBROMIDE	106-93-4	**0.011**	**0.0014**	1.0x10-6 cancer risk
HEXACHLOROBUTADIENE	87-68-3	**0.11**	**0.0103**	Non-Cancer risk: HI=0.2
METHYL ETHYL KETONE	78-93-3	12	4.1	90th%
METHYL ISOBUTYL KETONE	108-10-1	2.2	0.54	90th%
METHYL TERT BUTYL ETHER	1634-04-4	39	11	90th%
NAPHTHALENE	91-20-3	**0.61**	**0.12**	Non-Cancer risk: HI=0.2
C5 to C8 Aliphatics	NOS	58	15	50th%
C9 to C12 Aliphatics	NOS	68	11.2	50th%
C9 to C10 Aromatics	NOS	**10**	**1.6**	Non-Cancer risk: HI=0.2
STYRENE	100-42-5	1.4	0.33	90th%
TETRACHLOROETHANE, 1,1,2,2-	79-34-5	**0.041**	**0.0060**	1.0x10-6 cancer risk
TETRACHLOROETHYLENE	127-18-4	1.4	0.206	50th%
TOLUENE	108-88-3	54	14	90th%
TRICHLOROBENZENE, 1,2,4-	120-82-1	**3.4**	**0.46**	90th%
TRICHLOROETHANE, 1,1,1-	71-55-6	3.0	0.55	90th%
TRICHLOROETHANE, 1,1,2-	79-00-5	**0.15**	**0.027**	1.0x10-6 cancer risk
TRICHLOROETHYLENE	79-01-6	**0.80**	**0.15**	90th%
VINYL CHLORIDE	75-01-4	**0.27**	**0.11**	1.0x10-6 cancer risk
XYLENES (Mixed Isomers)	1330-20-7	20	4.6	Non-Cancer risk: HI=0.2

Note: Bolded values are Threshold Values that are below the lowest analytical Reporting Limit for the chemical obtained from three laboratories for Mass DEP APH and TO-15 Method (Scan Mode).

Attachment A Method Used to Establish Threshold Values for Multiple Line of Evidence

MassDEP established the Threshold Values in Table 1 for each chemical as follows:

- The 90th percentile value from the Typical Indoor Air Concentrations (Attachment B) was identified;
- The 90th percentile value was compared to the risk-based concentrations (Attachment C) calculated using an ELCR of 1X10^{-6} and an HI of 0.2. Cancer and non-cancer risk estimates were based on a conservative residential exposure scenario;
- If the risk-based concentration was higher than the 90th percentile value, then the 90th percentile value was used as the Threshold Value.
- If a risk-based concentration was lower than the 90th percentile value, but higher than the 50th percentile value, then the risk-based concentration was used as the Threshold Value.
- If the risk-based concentration was lower than the 50th percentile value, then the 50th percentile value was used as the Threshold Value.
- For chemicals that were either non-detects (NDs) in all of the selected studies or were detected less than 10% of the time (and therefore do not have an associated 50th, 75th or 90th percentile value), the highest analytical Reporting Limit provided for MassDEP APH and TO-15 (Scan Mode) (Attachment C) was as the Threshold Value, unless the Reporting Limit was higher than risk-based concentration, in which case the risk-based concentration was used as the Threshold Value.

Attachment B Typical Indoor Air Concentrations (from MassDEP Policy #08-XXX, 2008)

Chemical	CAS no.	Percentile Values from Studies (μg/m^3)		
			Upper Percentile Values	
		50th%	75th%	90th%
ACETONE	67-64-1	26	52	91
BENZENE	71-43-2	2.3	3.6	11
BROMODICHLOROMETHANE	75-27-4	ND	ND	ND
BROMOFORM	75-25-2	ND	ND	ND
BROMOMETHANE	74-83-9	ND	ND	0.6
CARBON TETRACHLORIDE	56-23-5	0.54	0.62	0.86
CHLOROBENZENE	108-90-7	ND	ND	ND
CHLOROFORM	67-66-3	1.9	2.6	3.0
DIBROMOCHLOROMETHANE	124-48-1	ND	ND	ND
DICHLOROBENZENE, 1,2- (o-DCB)	95-50-1	ND	ND	0.72
DICHLOROBENZENE, 1,3- (m-DCB)	541-73-1	ND	ND	0.6
DICHLOROBENZENE, 1,4- (p-DCB)	106-46-7	0.5	0.9	1.5
DICHLOROETHANE, 1,1-	75-34-3	ND	ND	ND
DICHLOROETHANE, 1,2-	107-06-2	ND	ND	ND
DICHLOROETHYLENE, 1,1-	75-35-4	ND	ND	ND
DICHLOROETHYLENE, CIS-1,2-	156-59-2	ND	ND	ND
DICHLOROETHYLENE, T-1,2-	156-60-5	ND	ND	ND
DICHLOROMETHANE (MeCl)	75-09-2	1.4	3.7	11
DICHLOROPROPANE, 1,2-	78-87-5	ND	ND	ND
DICHLOROPROPENE, cis, 1,3-	10061-01-5	ND	ND	ND
DICHLOROPROPENE, trans, 1,3-	10061-02-6	ND	ND	ND
DIOXANE, 1,4-	123-91-1	ND	ND	ND
ETHYLBENZENE	100-41-4	1.5	2.4	7.4
ETHYLENE DIBROMIDE	106-93-4	ND	ND	ND
HEXACHLOROBUTADIENE	87-68-3	ND	ND	4.6
METHYL ETHYL KETONE	78-93-3	3.4	5.3	12
METHYL ISOBUTYL KETONE	108-10-1	0.33	0.86	2.2
METHYL TERT BUTYL ETHER	1634-04-4	3.5	6.9	39
METHYLNAPHTHALENE, 2-	91-57-6	ND	ND	ND
NAPHTHALENE	91-20-3	ND	ND	2.7
C5 to C8 Aliphatics	NOS	58	130	330
C9 to C12 Aliphatics	NOS	68	110	220
C9 to C10 Aromatics	NOS	ND	ND	44
STYRENE	100-42-5	0.63	1.1	1.4
TETRACHLOROETHANE, 1,1,2,2-	79-34-5	ND	ND	ND
TETRACHLOROETHYLENE	127-18-4	1.4	2.4	4.1
TOLUENE	108-88-3	11	21	54
TRICHLOROBENZENE, 1,2,4-	120-82-1	ND	ND	3.4
TRICHLOROETHANE, 1,1,1-	71-55-6	0.5	1.1	3.0
TRICHLOROETHANE, 1,1,2-	79-00-5	ND	ND	ND
TRICHLOROETHYLENE	79-01-6	0.29	0.68	0.8
VINYL CHLORIDE	75-01-4	ND	ND	ND
XYLENES (Mixed Isomers)	1330-20-7	5.9	9.4	28

Attachment C	**Indoor Air Concentrations Calculated for MCP Significant Risk Management Criteria and Laboratory Reporting Limits**							
Chemical	**CAS no.**	**Risk Management Criteria**				**Analytical Laboratory Reporting Limits[1]**		
		HI = 0.2	HI = 1.0	**ELCR = 1x10^{-6}**	ELCR = 1x 10^{-5}	**Lab 1**	**Lab 2**	**Lab 3**
		µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3
ACETONE	67-64-1	160	800			1.2	5.9	1.2
BENZENE	71-43-2	6.0	30	0.30	3.0	1.6	0.6	0.6
BROMODICHLOROMETHANE	75-27-4	14	70	0.14	1.40	3.3	1.3	1.3
BROMOFORM	75-25-2	14	70	2.2	22	5.2	2.1	2.1
BROMOMETHANE	74-83-9	1.0	5.0			2.2	0.8	0.8
CARBON TETRACHLORIDE	56-23-5	86	430	0.16	1.6	1.3	1.3	1.3
CHLOROBENZENE	108-90-7	4.0	20			2.3	0.9	0.9
CHLOROFORM	67-66-3	130	650	0.11	1.1	2.4	1.0	1.0
DIBROMOCHLOROMETHANE	124-48-1	14	70	0.10	1.0	4.3	1.7	1.7
DICHLOROBENZENE, 1,2- (o-DCB)	95-50-1	40	200			3.0	1.2	1.2
DICHLOROBENZENE, 1,3- (m-DCB)	541-73-1	40	200			3.0	1.2	1.2
DICHLOROBENZENE, 1,4- (p-DCB)	106-46-7	160	800	0.35	3.5	3.0	1.2	1.2
DICHLOROETHANE, 1,1-	75-34-3	100	500			0.8	0.8	0.8
DICHLOROETHANE, 1,2-	107-06-2	11	55	0.09	0.90	0.8	0.8	0.8
DICHLOROETHYLENE, 1,1-	75-35-4	40	200			0.8	0.8	0.8
DICHLOROETHYLENE, CIS-1,2-	156-59-2	7.0	35			0.8	0.8	0.8
DICHLOROETHYLENE, T-1,2-	156-60-5	14	70			0.8	0.8	0.8
DICHLOROMETHANE (MeCl)	75-09-2	600	3000	5.0	50	1.7	1.7	1.7
DICHLOROPROPANE, 1,2-	78-87-5	0.80	4.0	0.13	1.3	2.3	0.9	0.9
DICHLOROPROPENE, cis, 1,3-	10061-01-5	4.0	20	0.60	6.0	2.3	0.9	0.9
DICHLOROPROPENE, trans, 1,3-	10061-02-6	4.0	20	0.60	6.0	2.3	0.9	0.9

[1] Analytical Reporting Limits using MassDEP APH Method or the TO-15 Method (Scan Mode) for the chemicals obtained from three laboratories.

Attachment C **Indoor Air Concentrations Calculated for MCP Significant Risk Management Criteria and Laboratory Reporting Limits**

Chemical	CAS no.	Risk Management Criteria				Analytical Laboratory Reporting Limits[1]		
		HI = 0.2	HI = 1.0	**ELCR = 1x10^{-6}**	ELCR = 1x 10^{-5}	**Lab 1**	**Lab 2**	**Lab 3**
		µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3
DIOXANE, 1,4-	123-91-1	24	120	0.59	5.9	1.8	3.6	18
ETHYLBENZENE	100-41-4	200	1000			2.2	0.9	0.9
ETHYLENE DIBROMIDE	106-93-4	1.8	9	0.011	0.11	3.8	NR	1.5
HEXACHLOROBUTADIENE	87-68-3	0.14	0.70	0.11	1.1	5.3	2.1	2.1
METHYL ETHYL KETONE	78-93-3	1000	5000			1.5	1.5	1.5
METHYL ISOBUTYL KETONE	108-10-1	600	3000			2.0	2.0	2.0
METHYL TERT BUTYL ETHER	1634-04-4	600	3000			1.8	0.7	1.8
NAPHTHALENE	91-20-3	0.61	3.1			2.6	2.0	2.6
C5 to C8 Aliphatics	NOS	40	200			11	24	NR
C9 to C12 Aliphatics	NOS	40	200			18	28	NR
C9 to C10 Aromatics	NOS	10	50			13	24	NR
STYRENE	100-42-5	200	1000	4.1	41	2.1	0.9	0.9
TETRACHLOROETHANE, 1,1,2,2-	79-34-5	19	95	0.041	0.41	1.4	1.4	1.4
TETRACHLOROETHYLENE	127-18-4	920	4600	0.23	2.3	1.4	1.4	1.4
TOLUENE	108-88-3	1000	5000			1.9	0.8	0.8
TRICHLOROBENZENE, 1,2,4-	120-82-1	40	200			3.7	3.7	3.7
TRICHLOROETHANE, 1,1,1-	71-55-6	1100	5500			1.1	1.1	1.1
TRICHLOROETHANE, 1,1,2-	79-00-5	15	75	0.15	1.5	1.1	1.1	1.1
TRICHLOROETHYLENE	79-01-6	36	180	1.4	14	1.1	1.1	1.1
VINYL CHLORIDE	75-01-4	20	100	0.27	2.7	0.5	0.5	0.5
XYLENES (Mixed Isomers)	1330-20-7	20	100			2.2	1.7	2.2